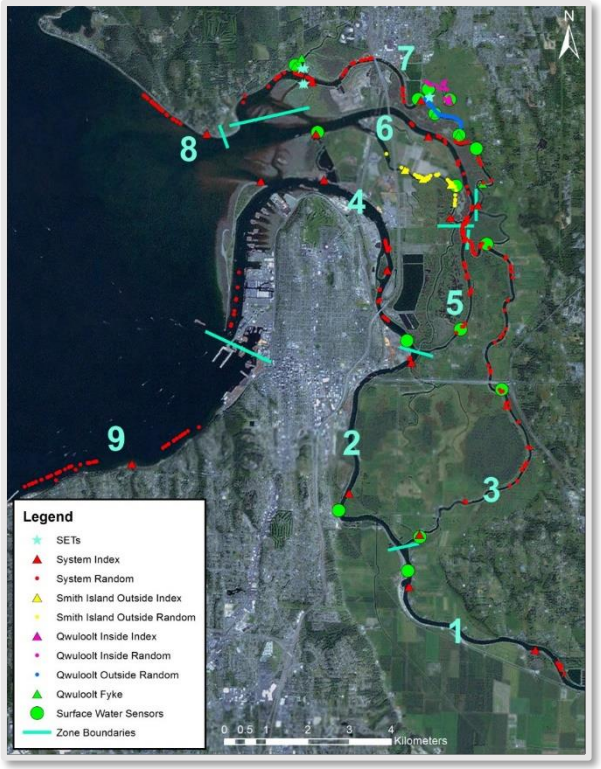
Snohomish estuary Chinook salmon

Status updates from system- and project-level monitoring

Joshua Chamberlin, Jason Hall, Todd Zackey, Frank Leonetti and Mike Rustay

Develop comprehensive framework to evaluate impact of estuary restoration on Chinook salmon population

System Level

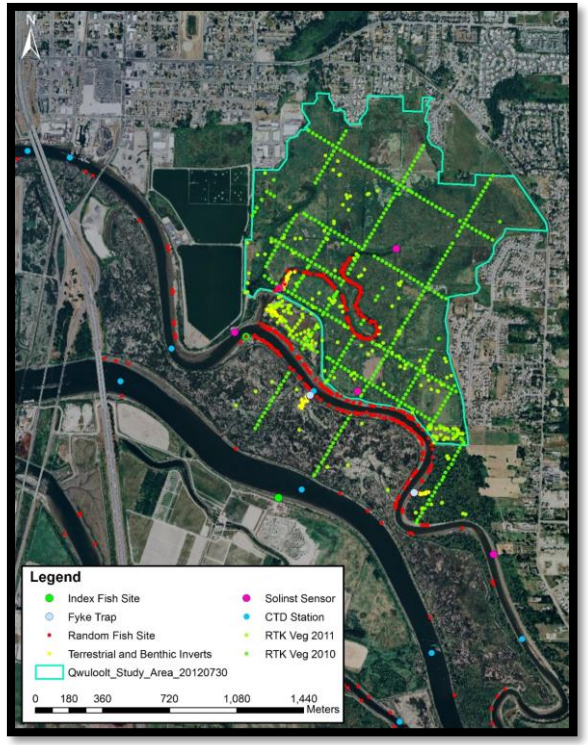


What are the patterns of fish use across the estuary?
What are hydro and sediment dynamics and their relation to fish?
How will these change with ongoing restoration?

<u>Measured attributes</u>

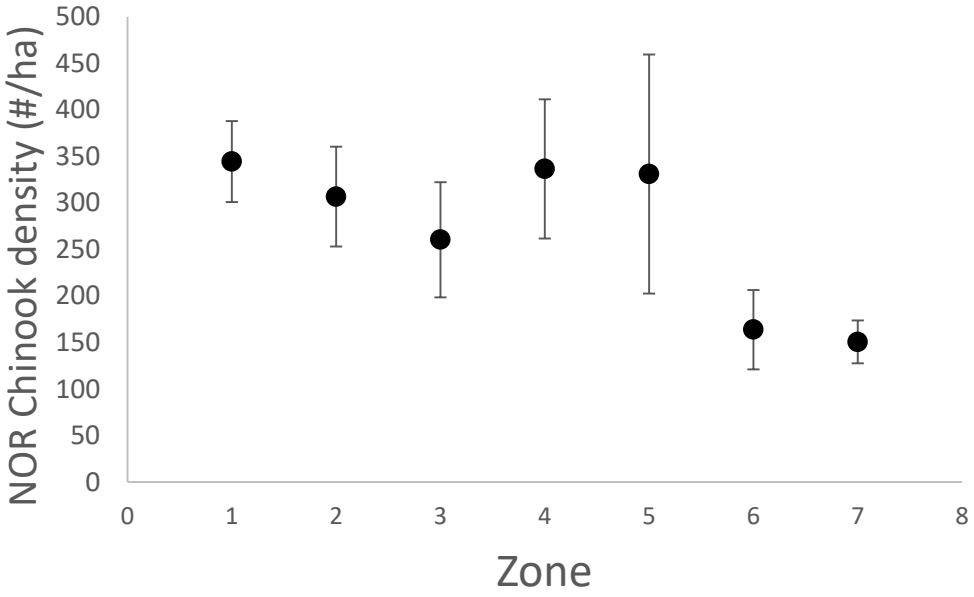
- Biotic:
  - Fish
  - Vegetation
  - Insects
  - Birds
- Abiotic
  - Temperature/Salinity
  - Sediment accretion/loss
  - Elevation
  - Flow

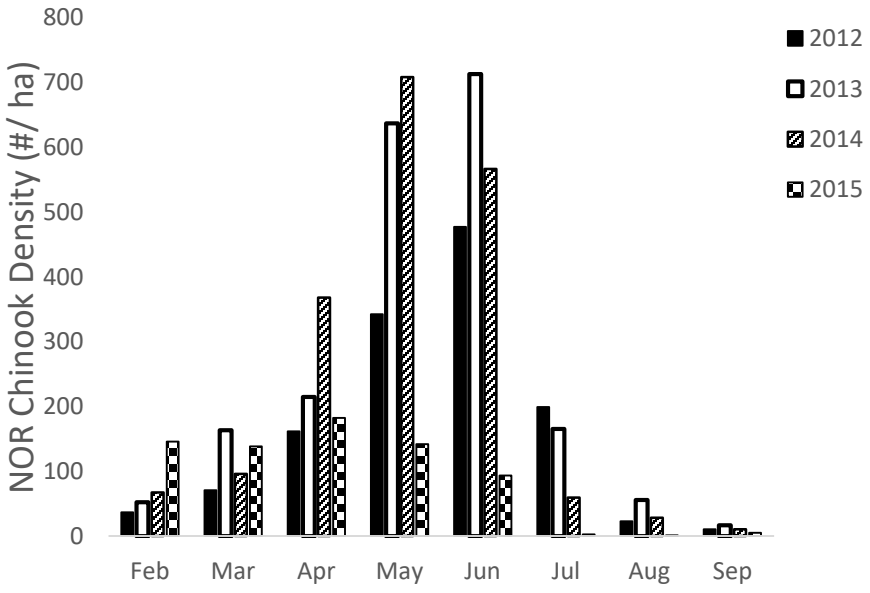
Project Level

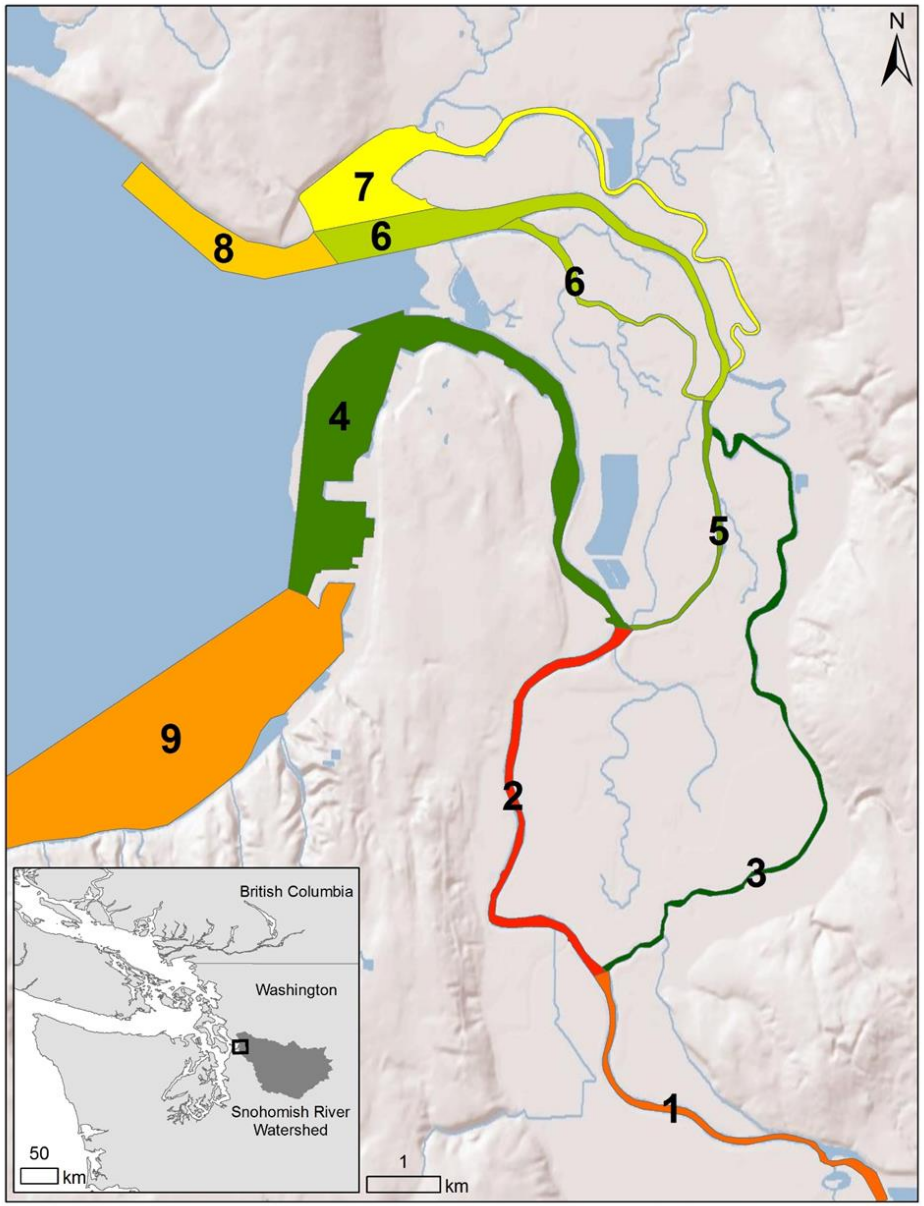


What are the pre/post-breach conditions at Qwuloolt?
What is the likely trajectory? Inform future projects?
Does local Chinook salmon use and/or abundance change?

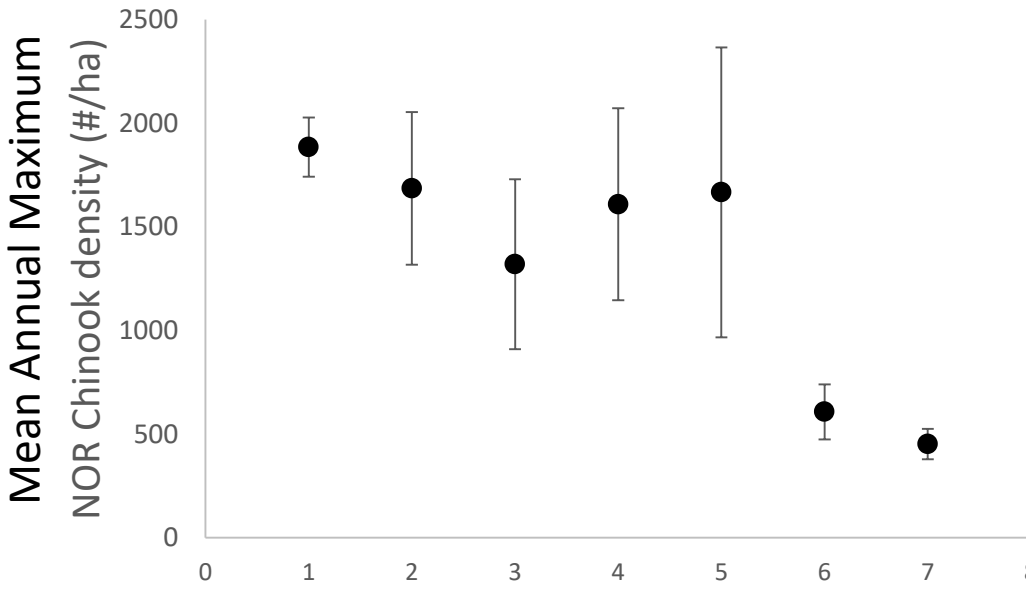
Spatial and temporal patterns in NOR Chinook density across the landscape

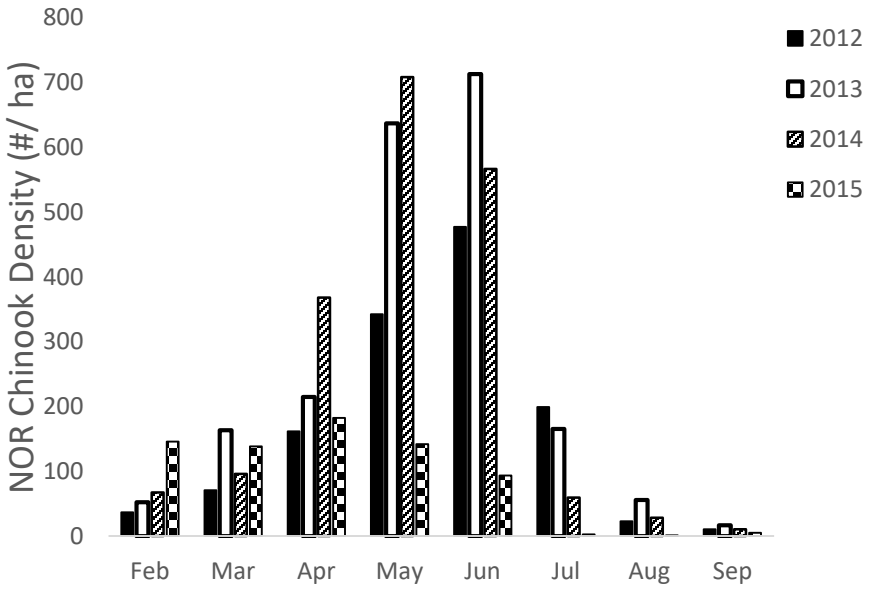


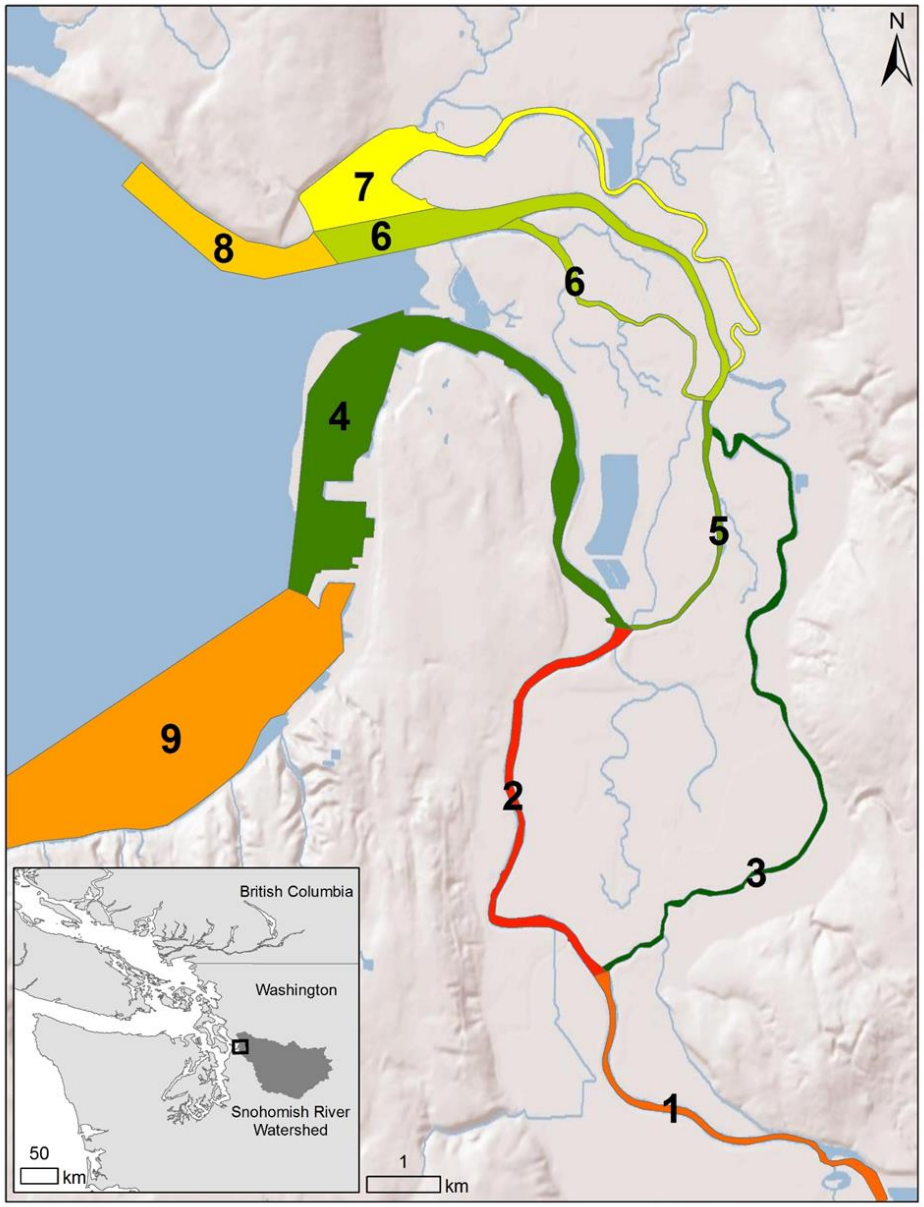




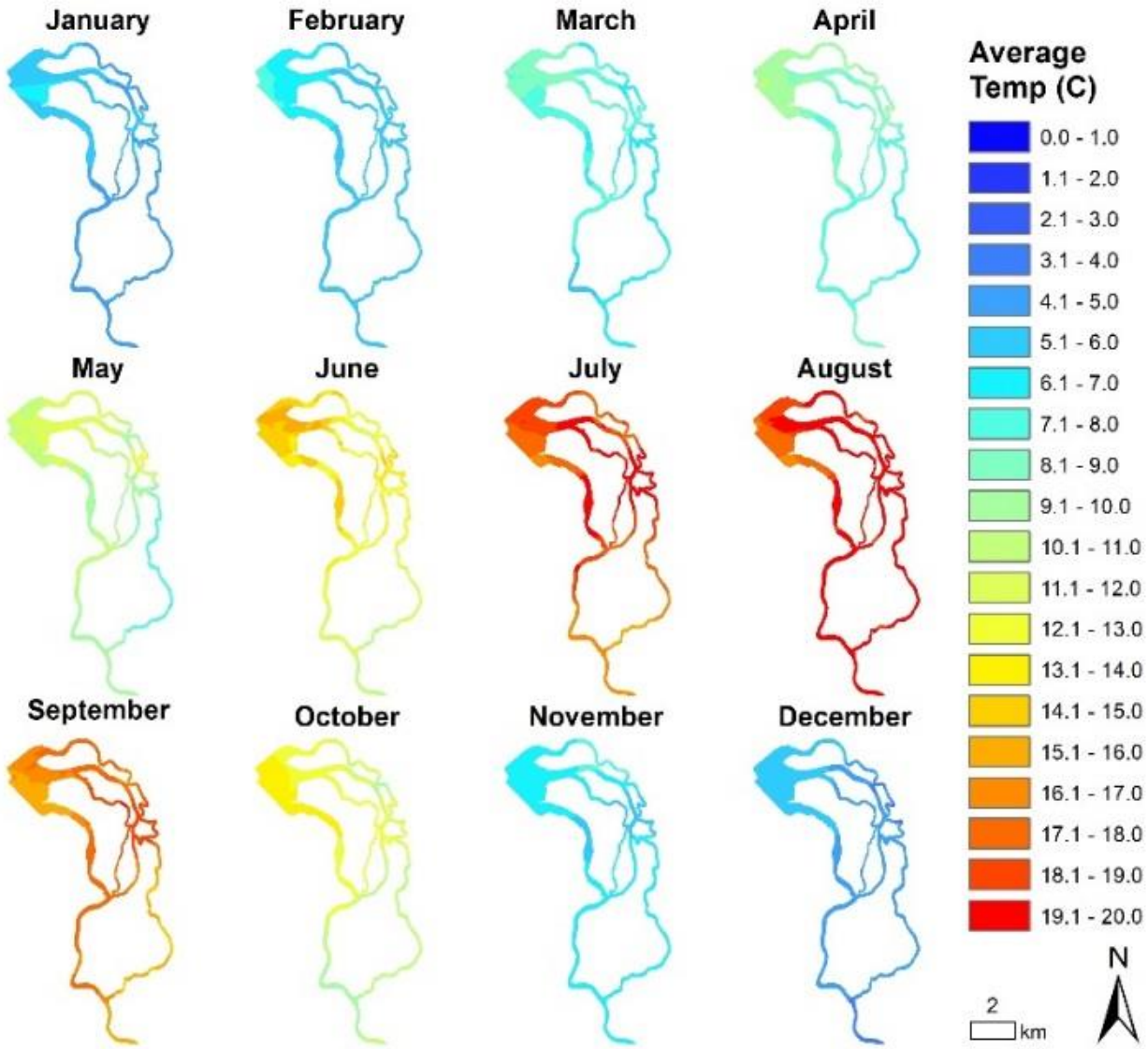
Spatial and temporal patterns in NOR Chinook density across the landscape





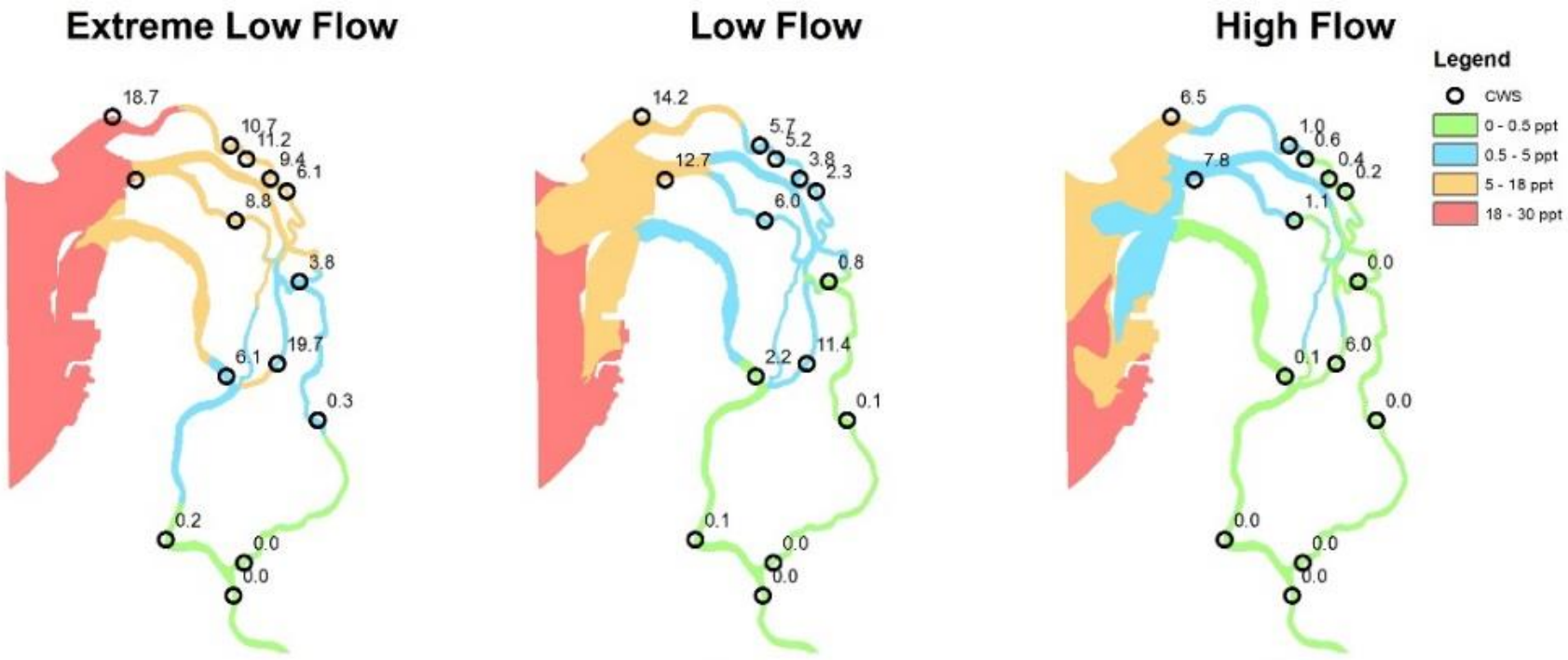


Temperature is seasonal and varies spatially



Hall et al. 2018

Salinity less variable seasonally, strongly related to flow with distinct "zones" in the estuary



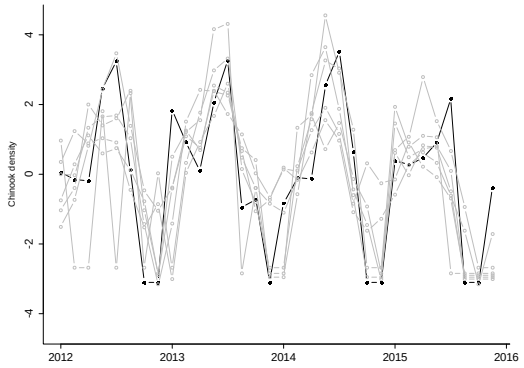
Aug-Sep

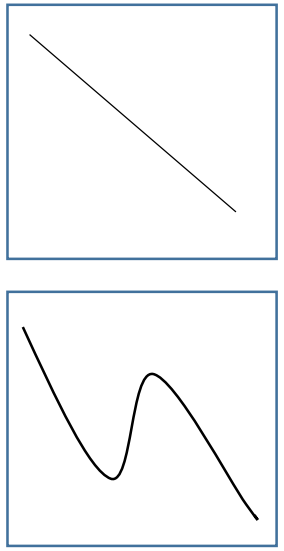
Oct-Apr

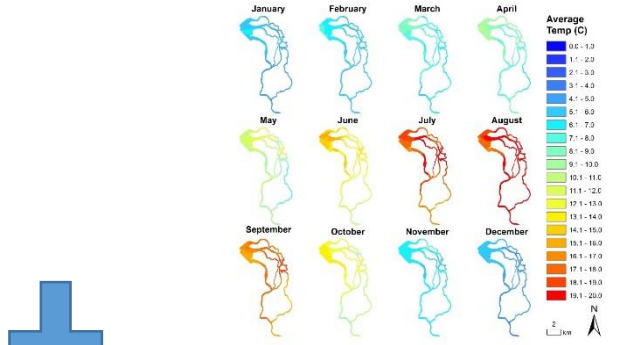
May-Jun

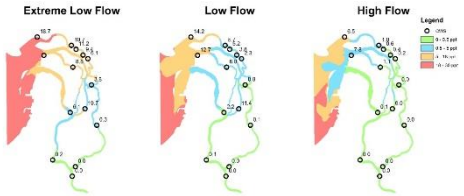
Hall et al. 2018

Multiple messy time series into generalized trends—quantify the effect of temp and salinity

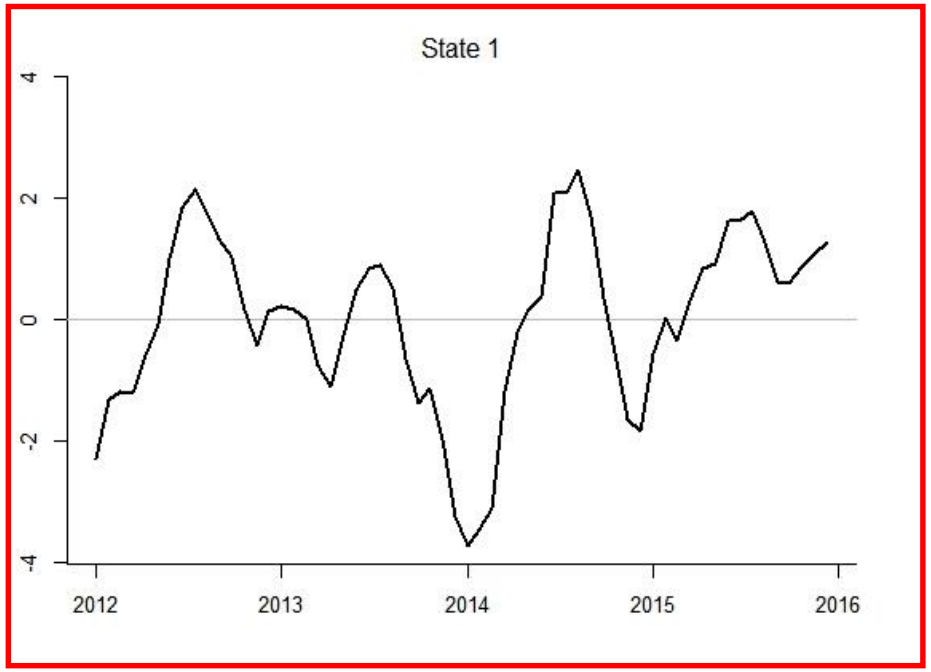


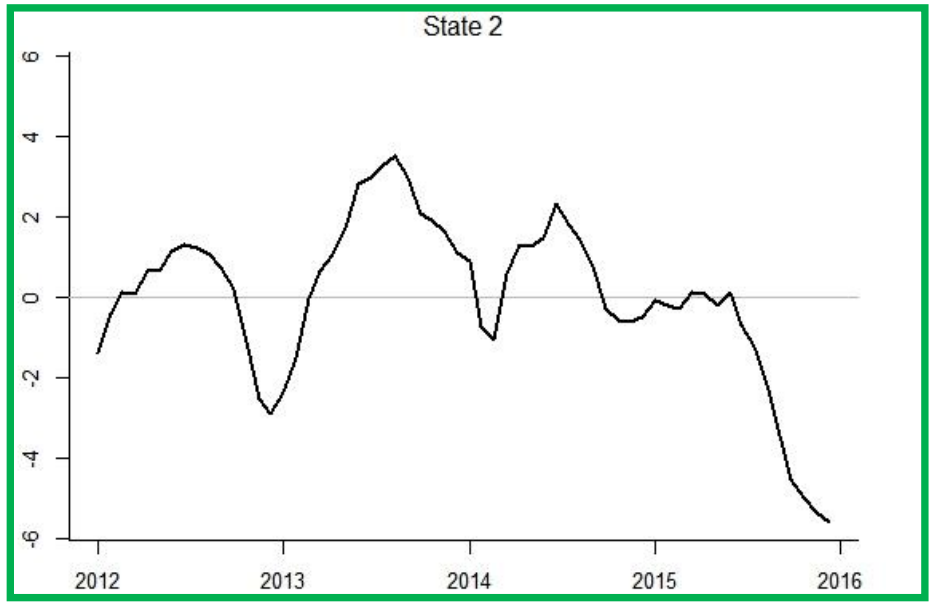


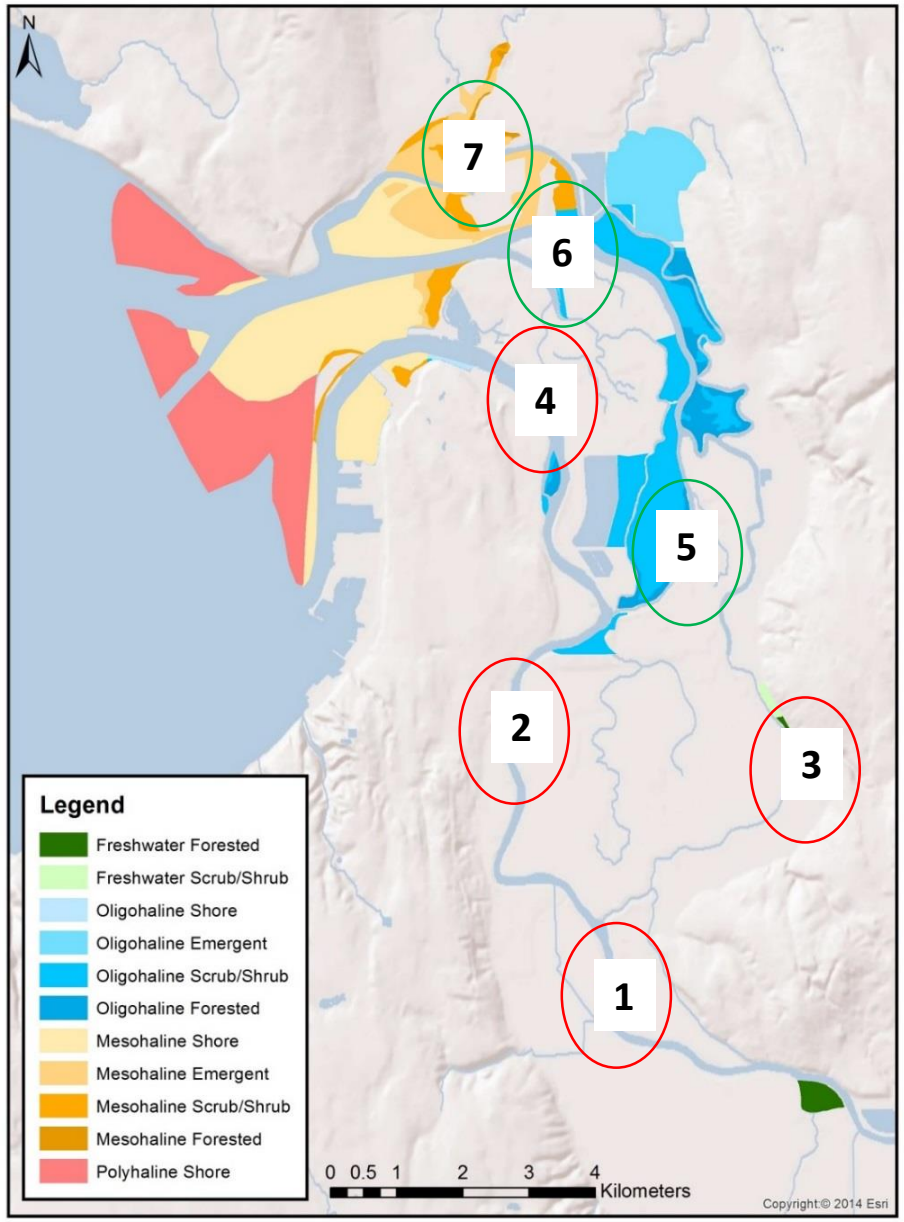




Generalized trends in NOR Chinook distribution and abundance



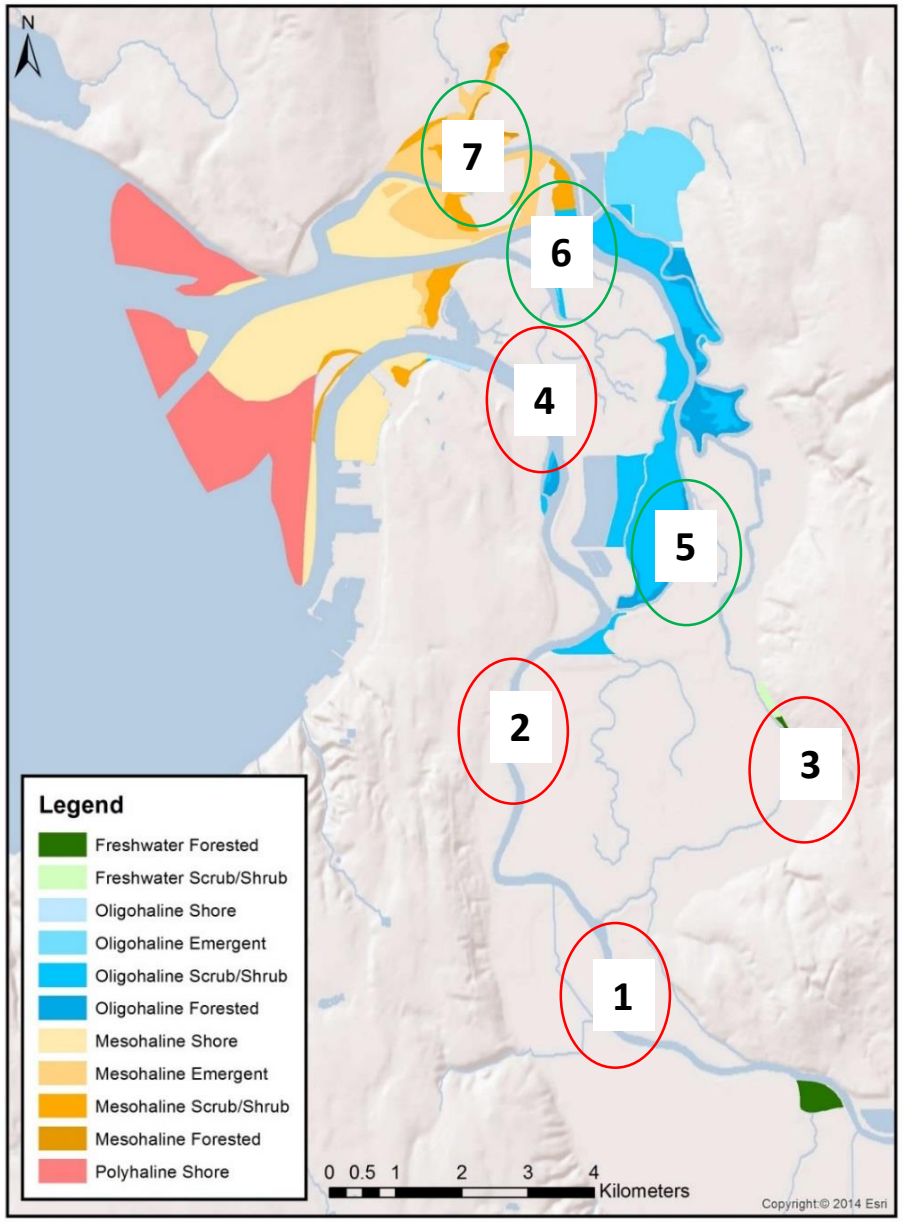




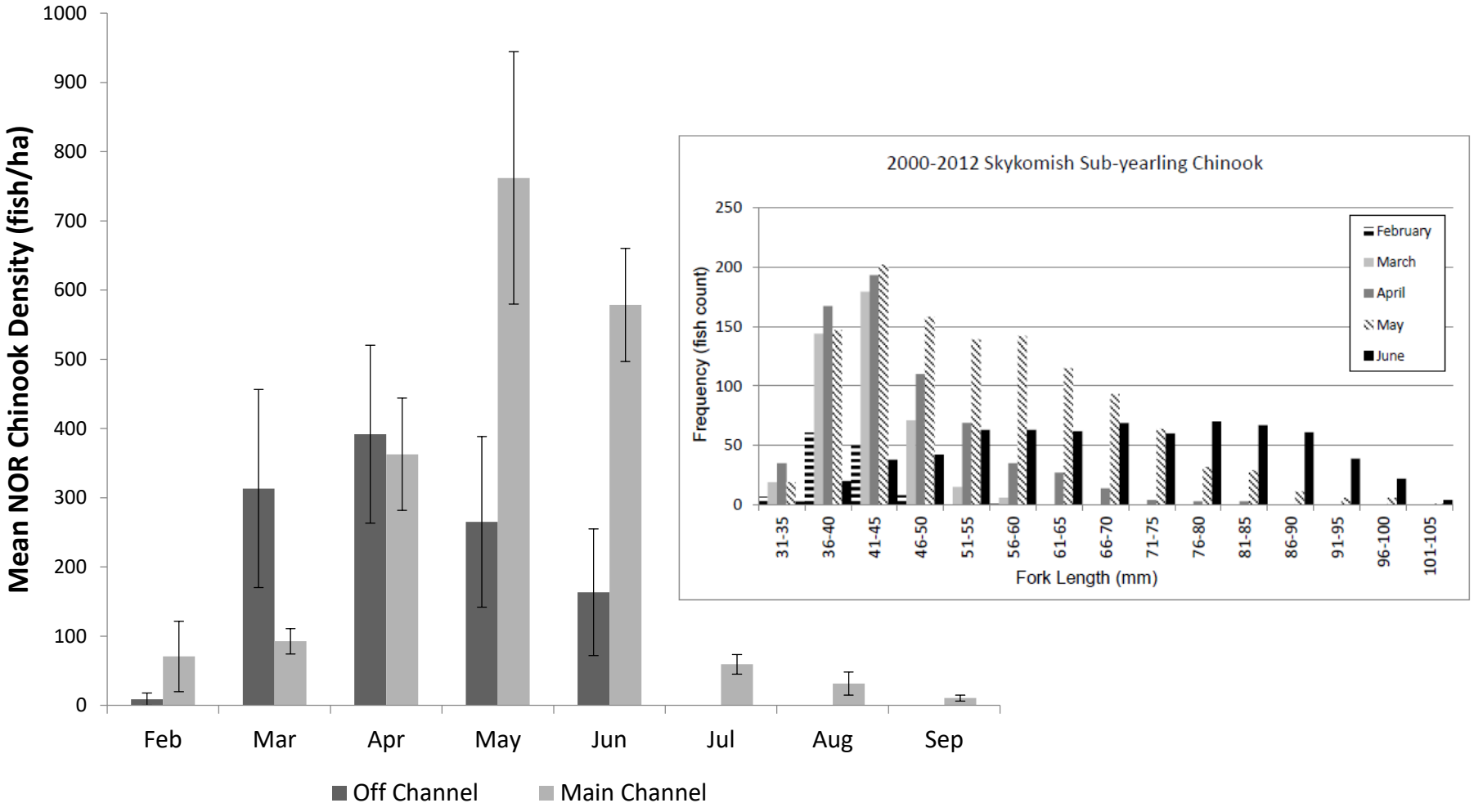
Generalized trends in NOR Chinook distribution and abundance

- Relatively low early season density
- Sharp increases/decreases
- Higher peaks

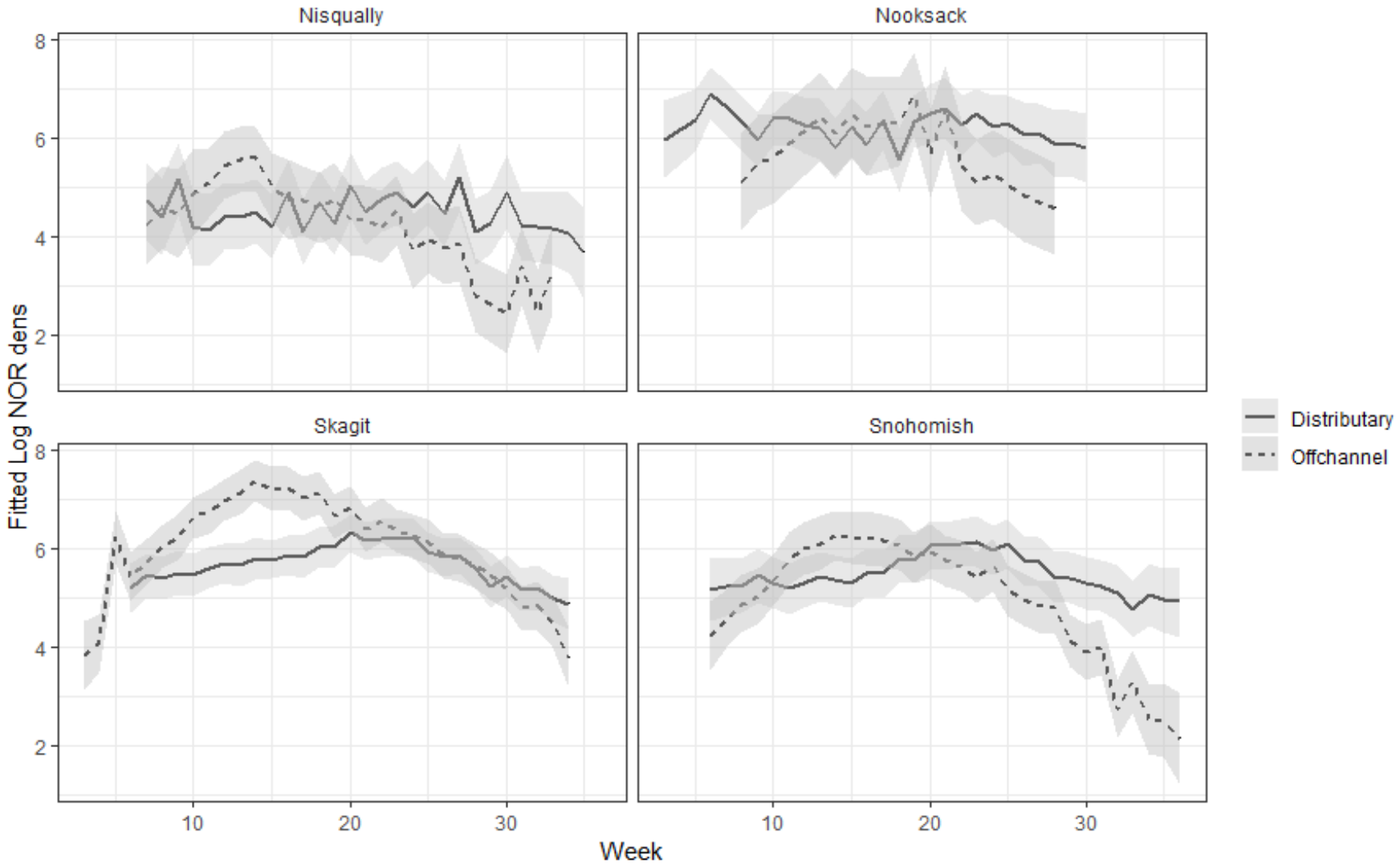
- Higher relative densities earlier in the season
- Gradual increases/decreases
- Lower magnitude peaks, longer duration



Spatial differences in trends likely reflects rearing in the estuary

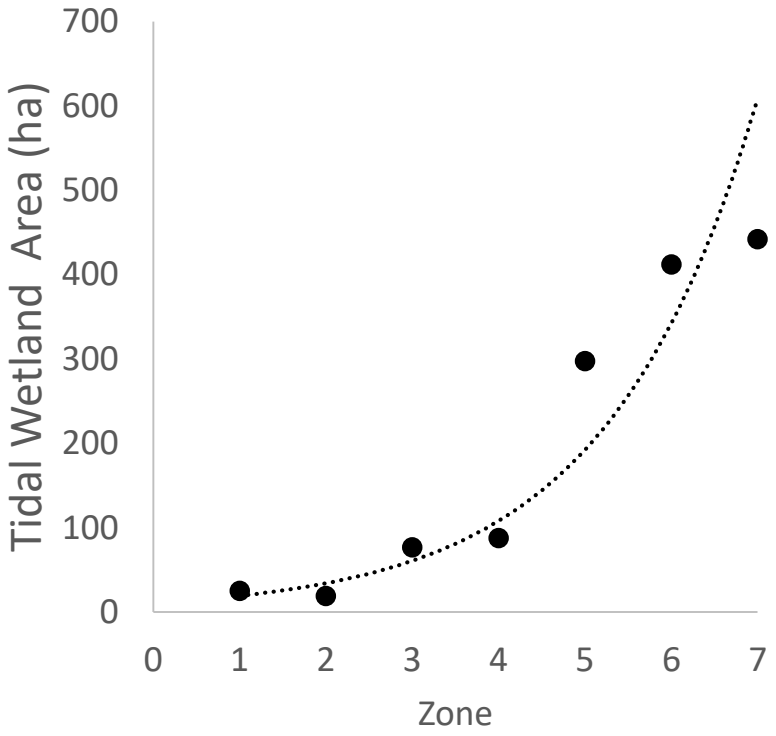


Temporal rearing pattern consistent among other large river deltas in Puget Sound

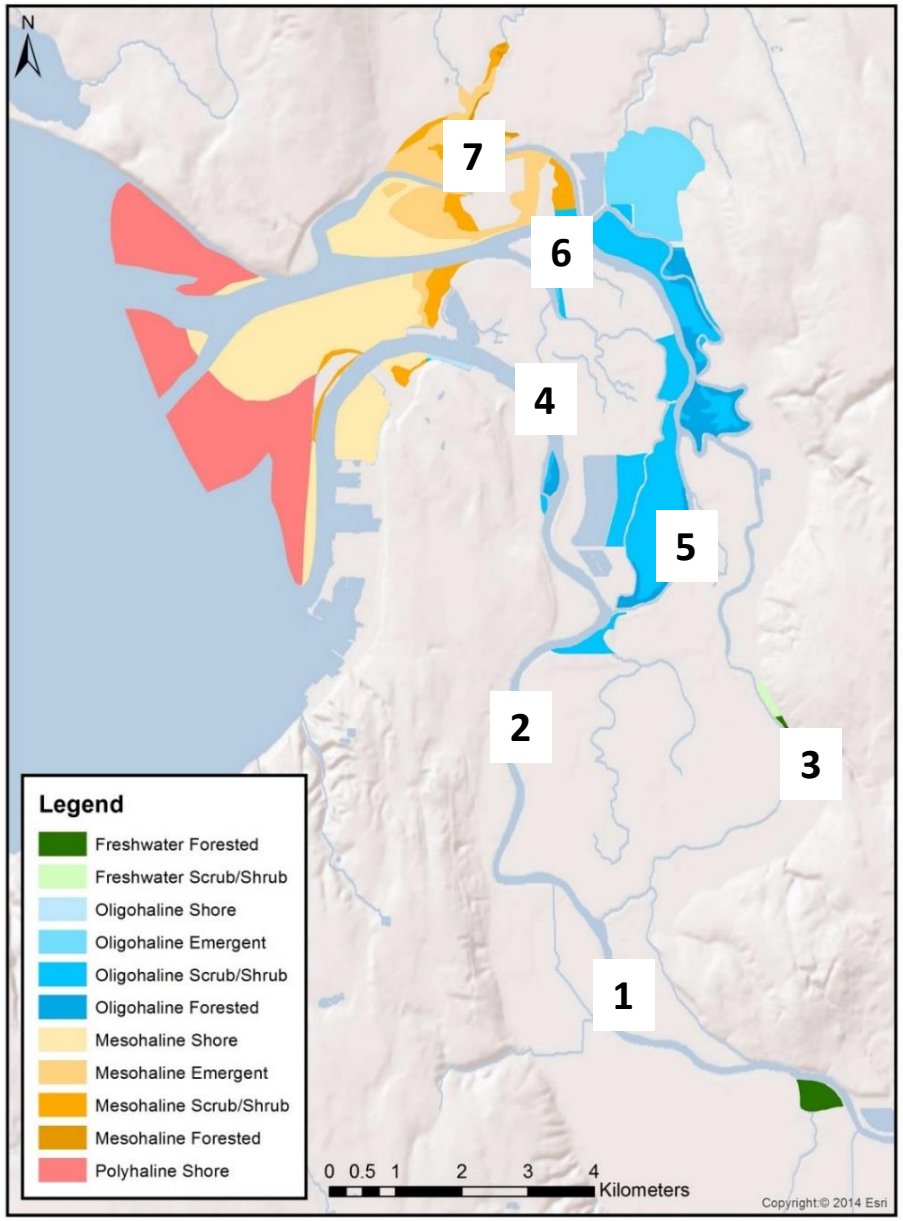


Beamer et al. in review

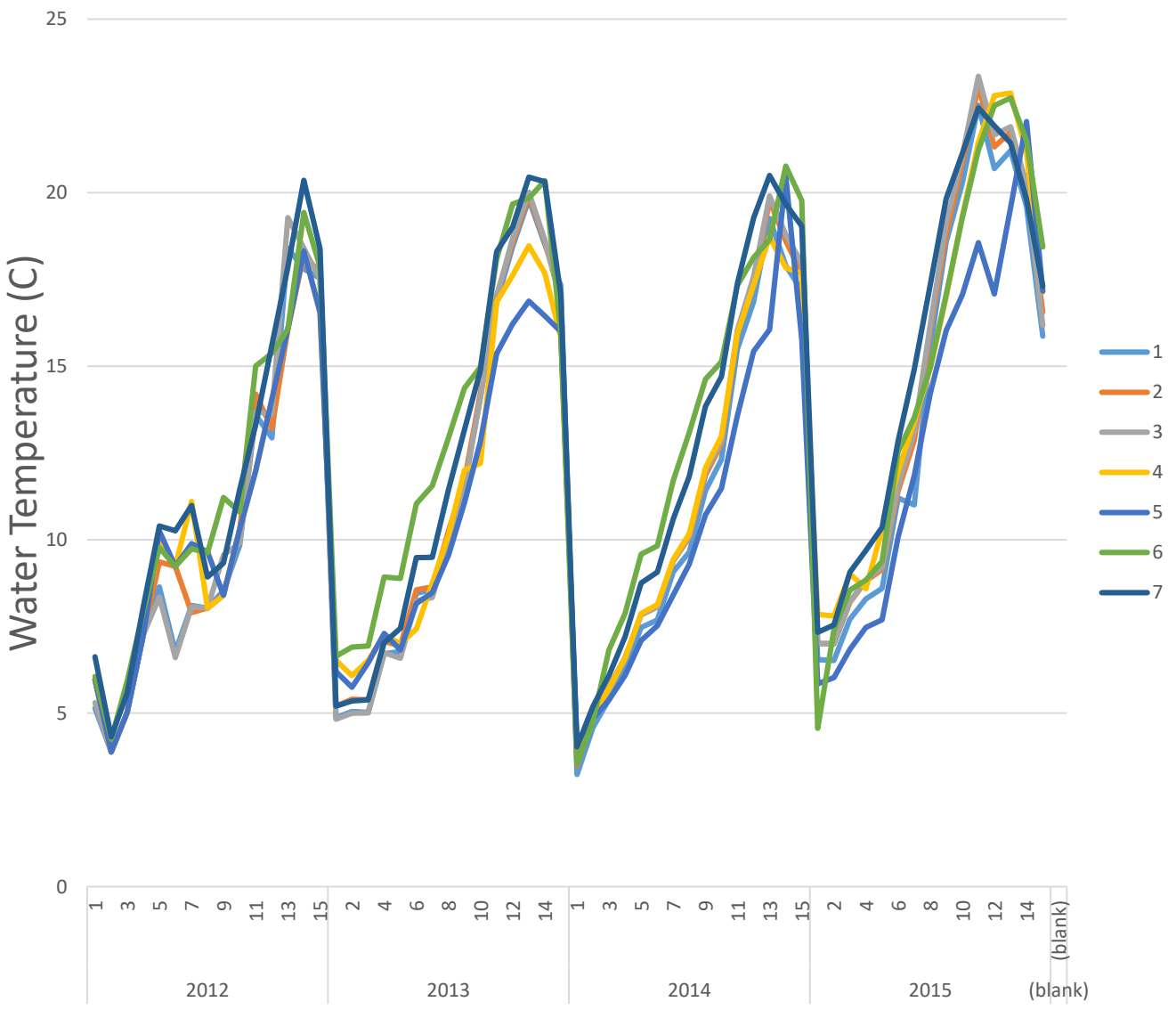
Distribution of rearing habitat consistent with NOR Chinook distribution trend



Overwhelming majority of available rearing habitat in lower estuary

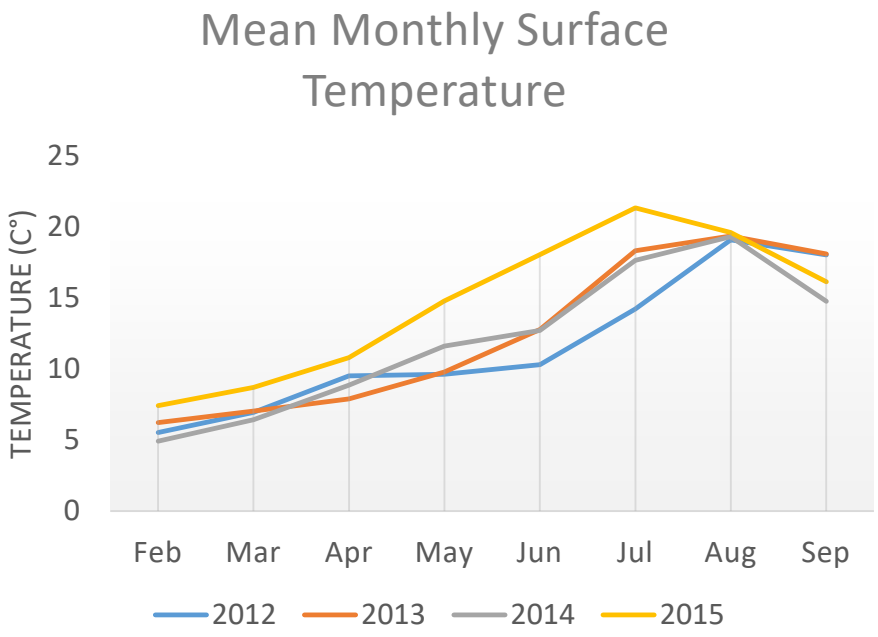


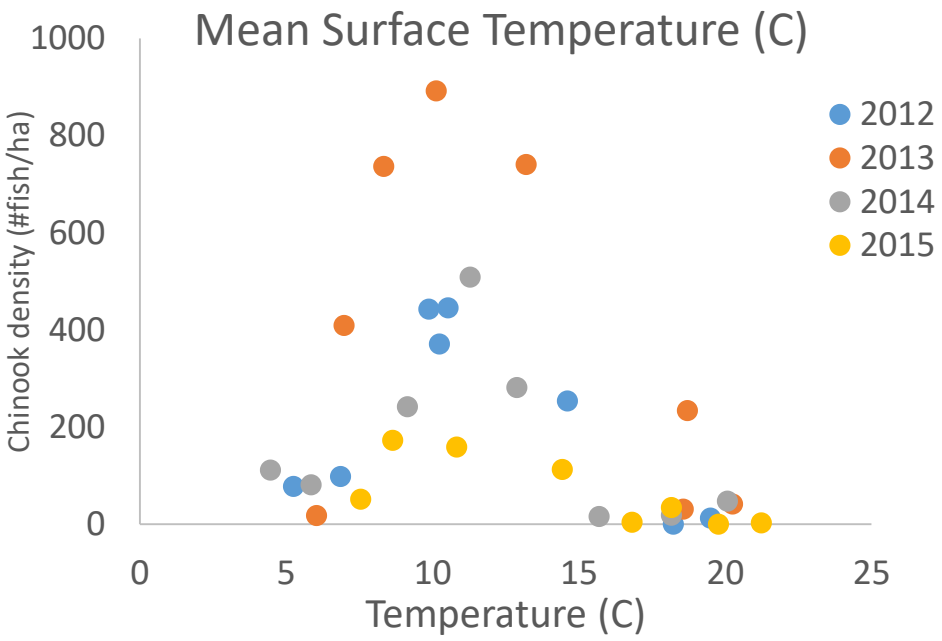
Water temperature time series across the landscape



Significant negative effect of temperature on NOR density

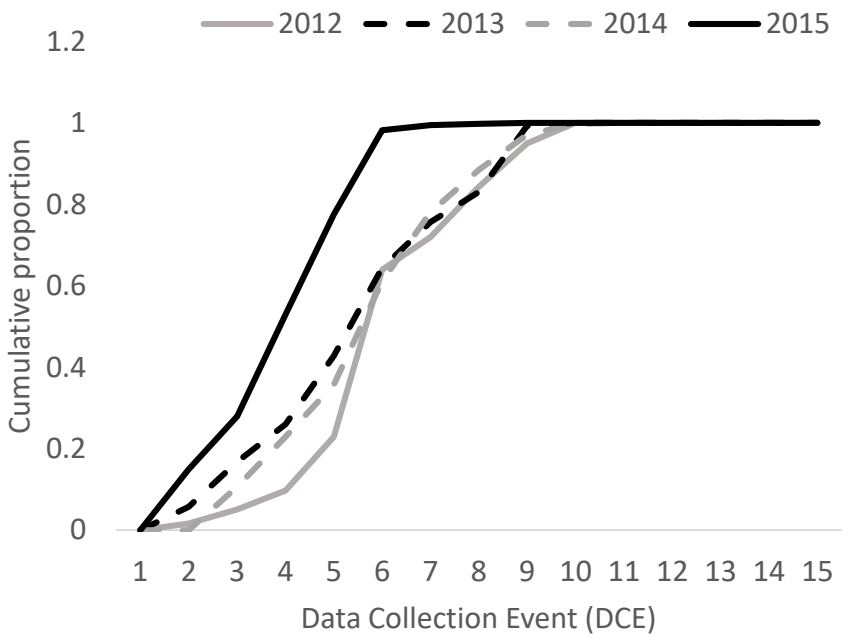
Temperature trajectory influences fish abundance

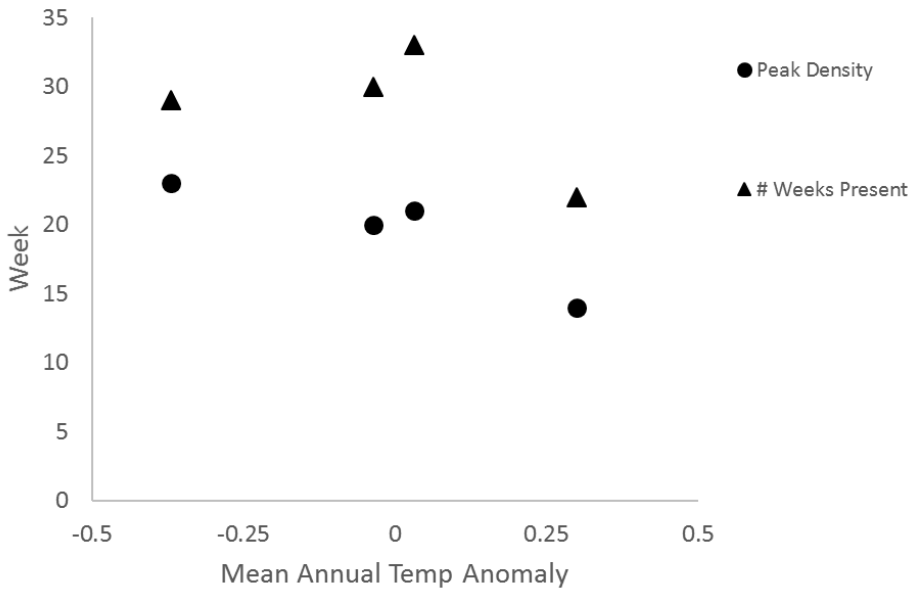




- Seasonal trajectories and monthly maximums vary annually
- Potential threshold or tipping point near 12 C?

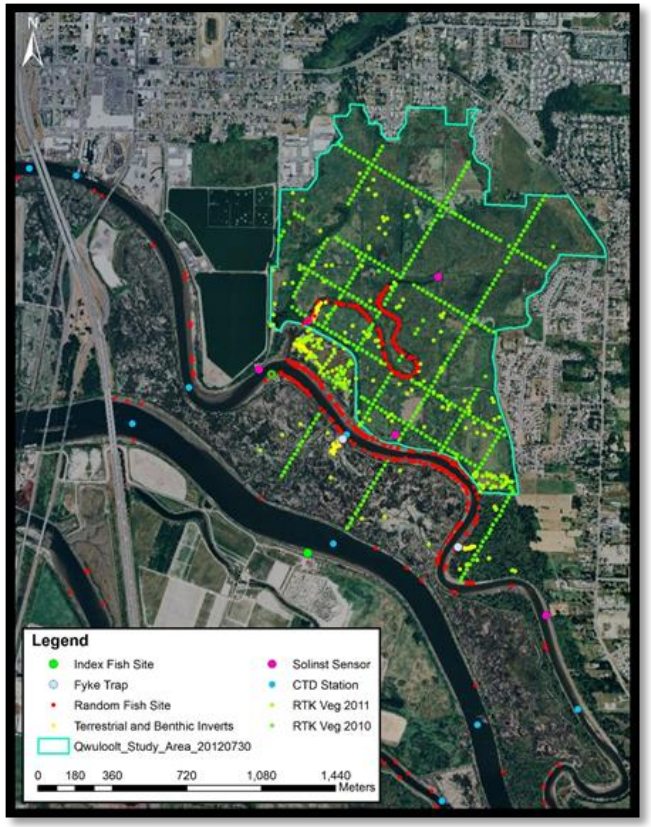
Temperature patterns can affect duration and magnitude of fish presence in the system

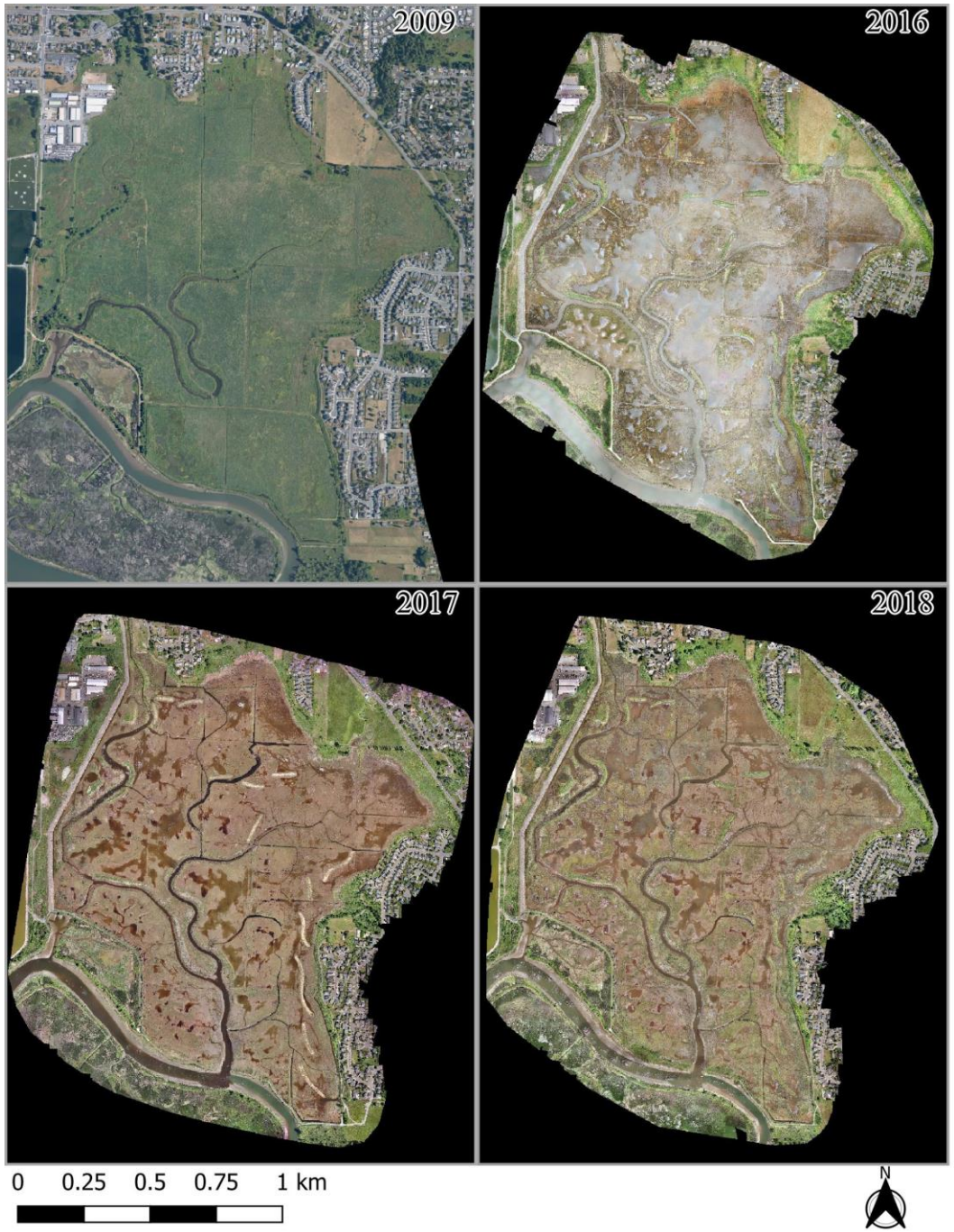




- Total Cumulative abundance reached earlier/quicker in warm years
- Peak abundance occurs earlier in warm years
- Duration of NOR presence shorter in warm years

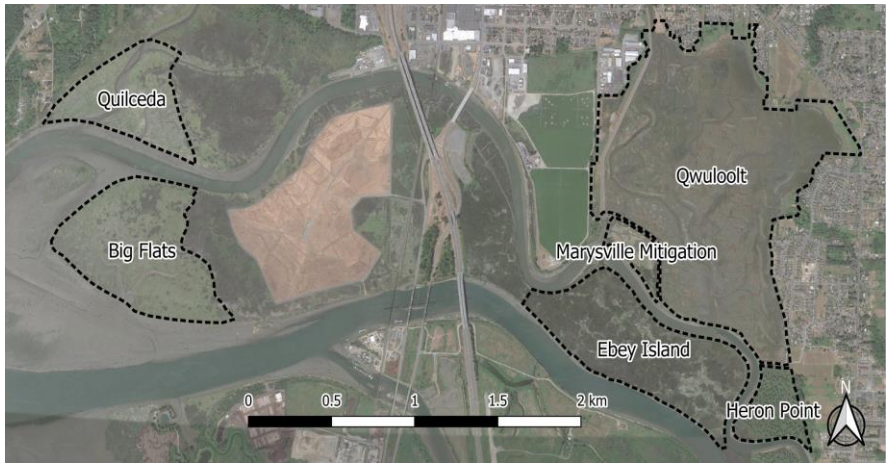
Qwuloolt: Project-level updates

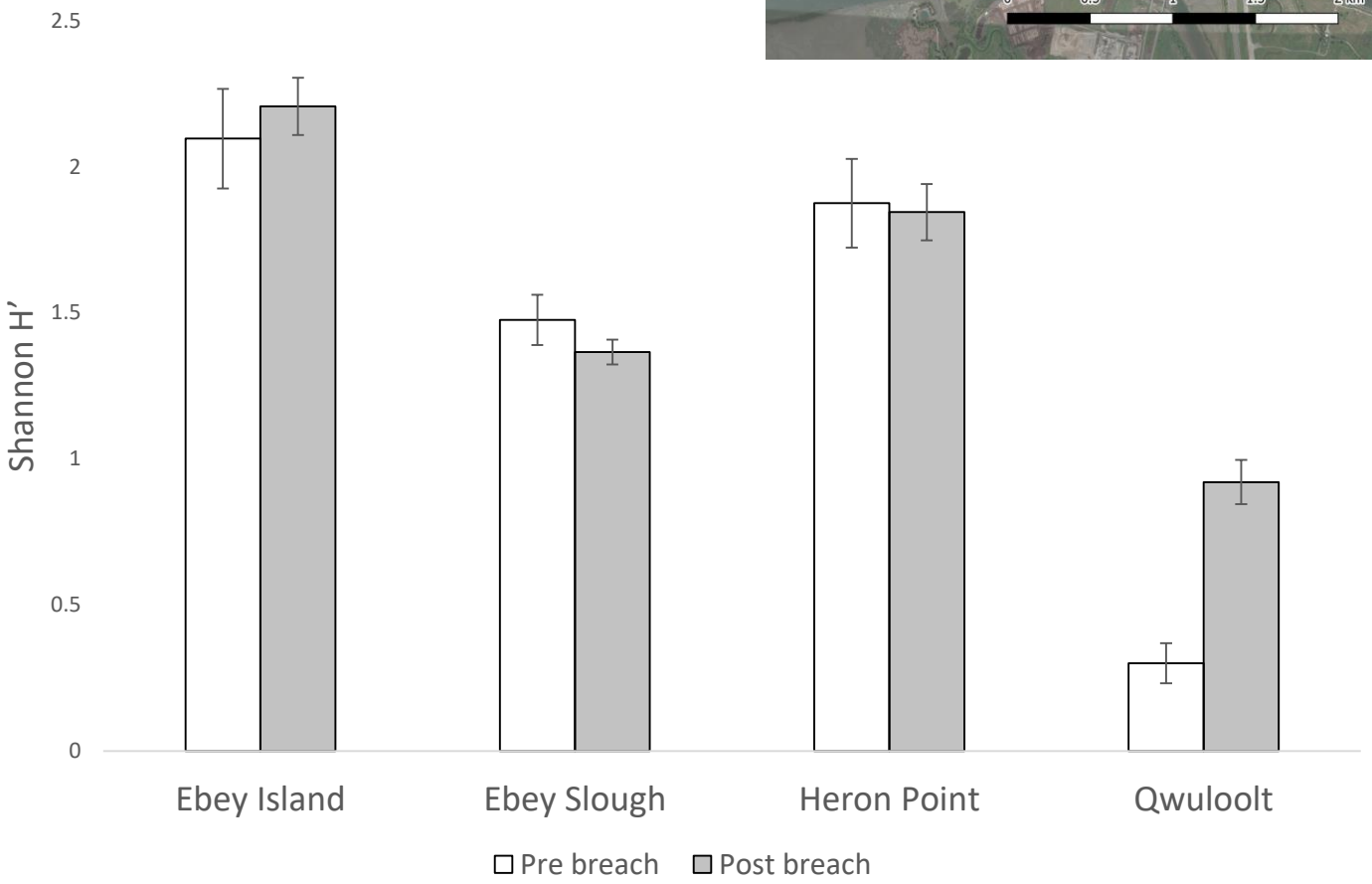




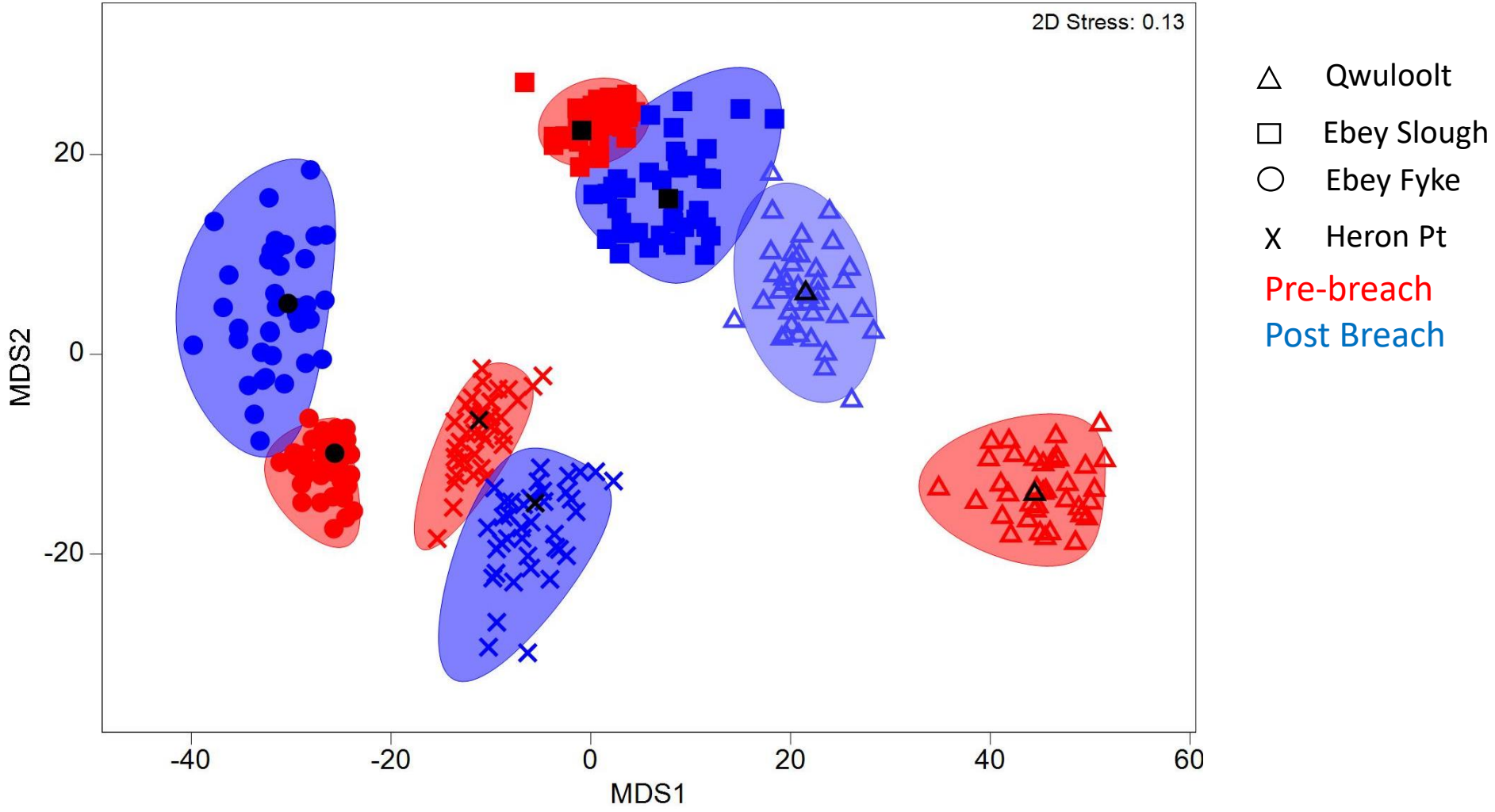
- Has fish diversity/assemblage changed?
- Are Chinook using the site?
- Consistent (e.g. size, abundance) with reference sites/expectations?

Increased fish diversity at Qwuloolt, trending toward reference sites



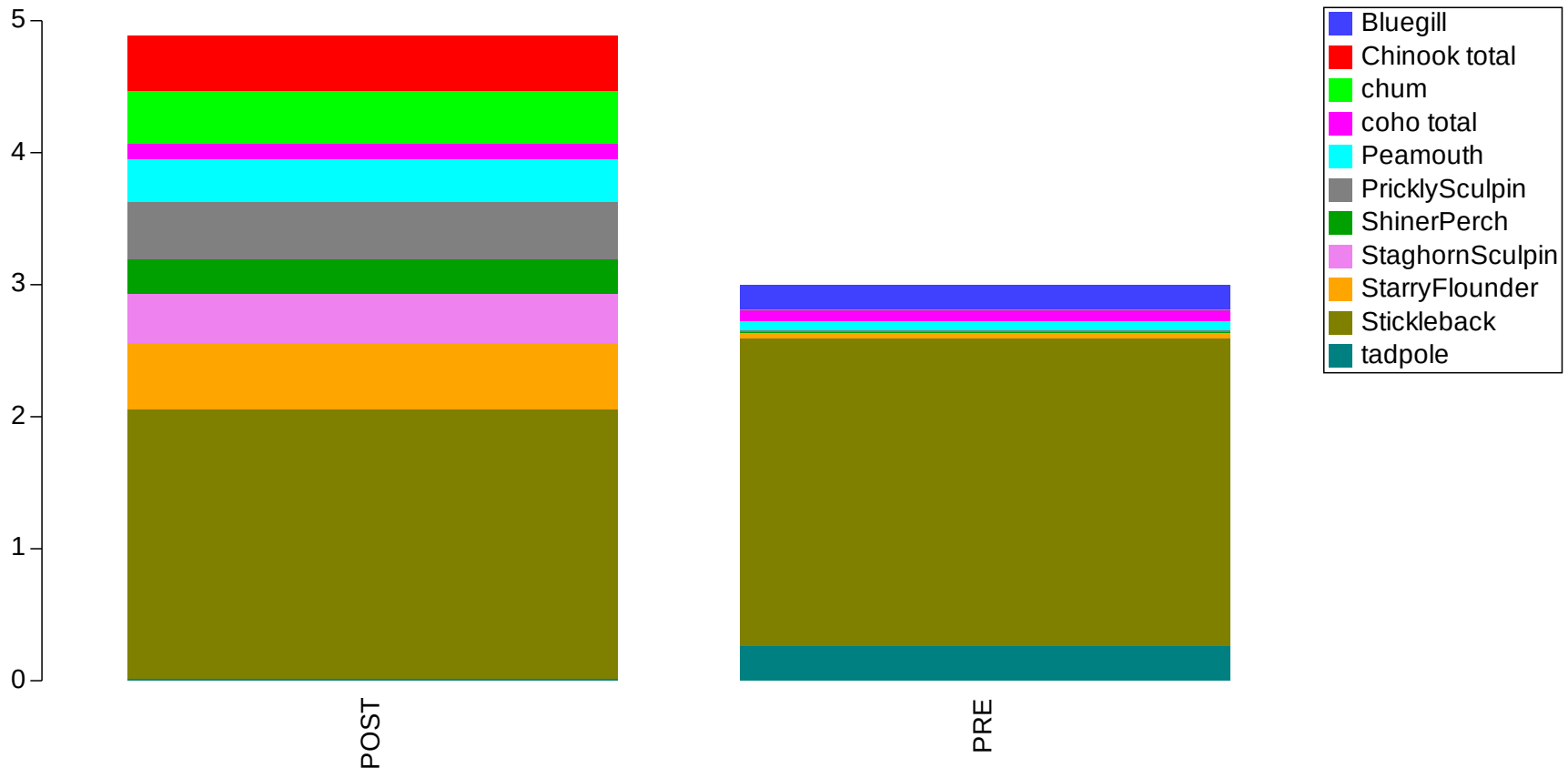


Before/After Restoration fish assemblage comparisons

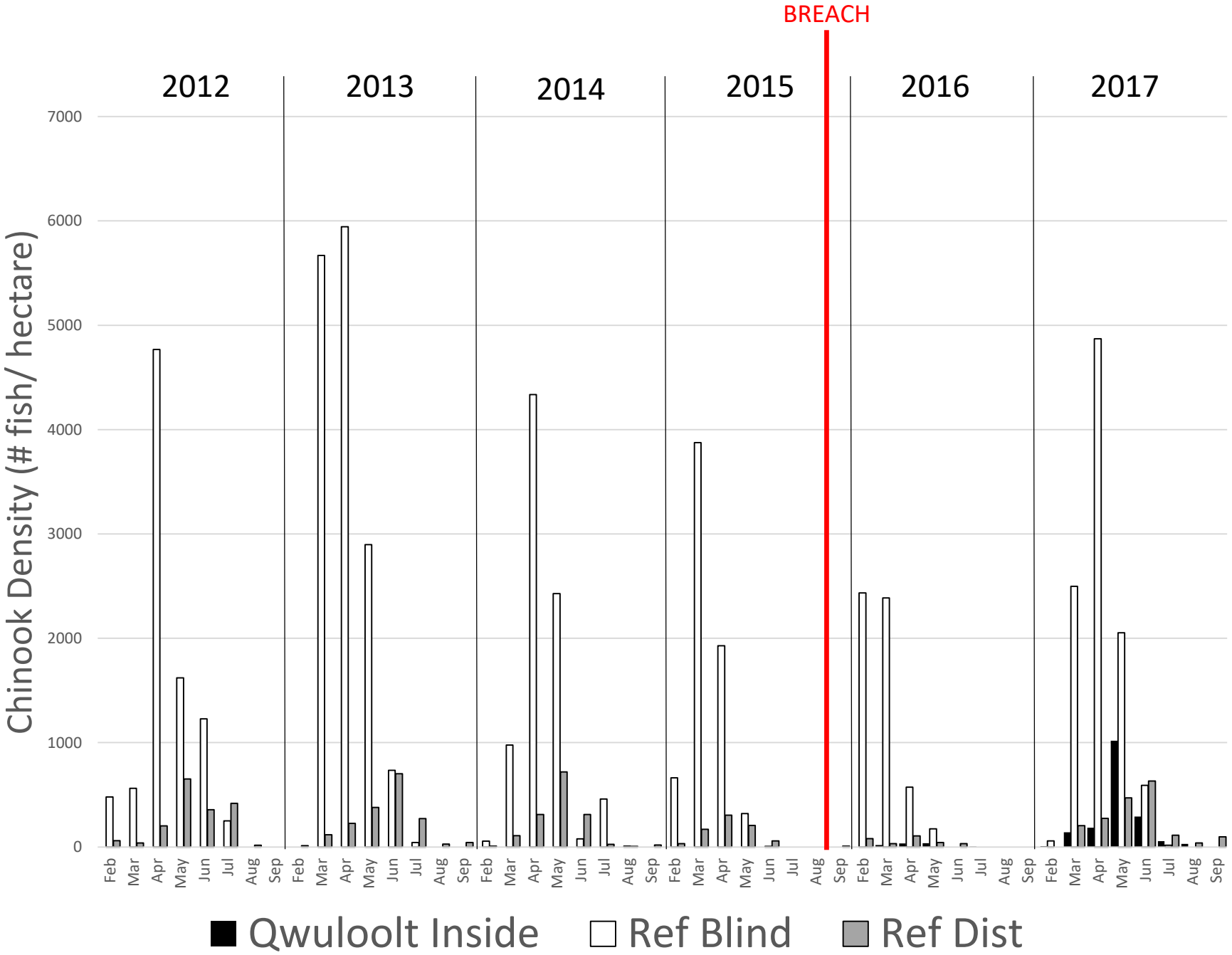


Qwuloolt trending toward reference/estuarine assemblage conditions

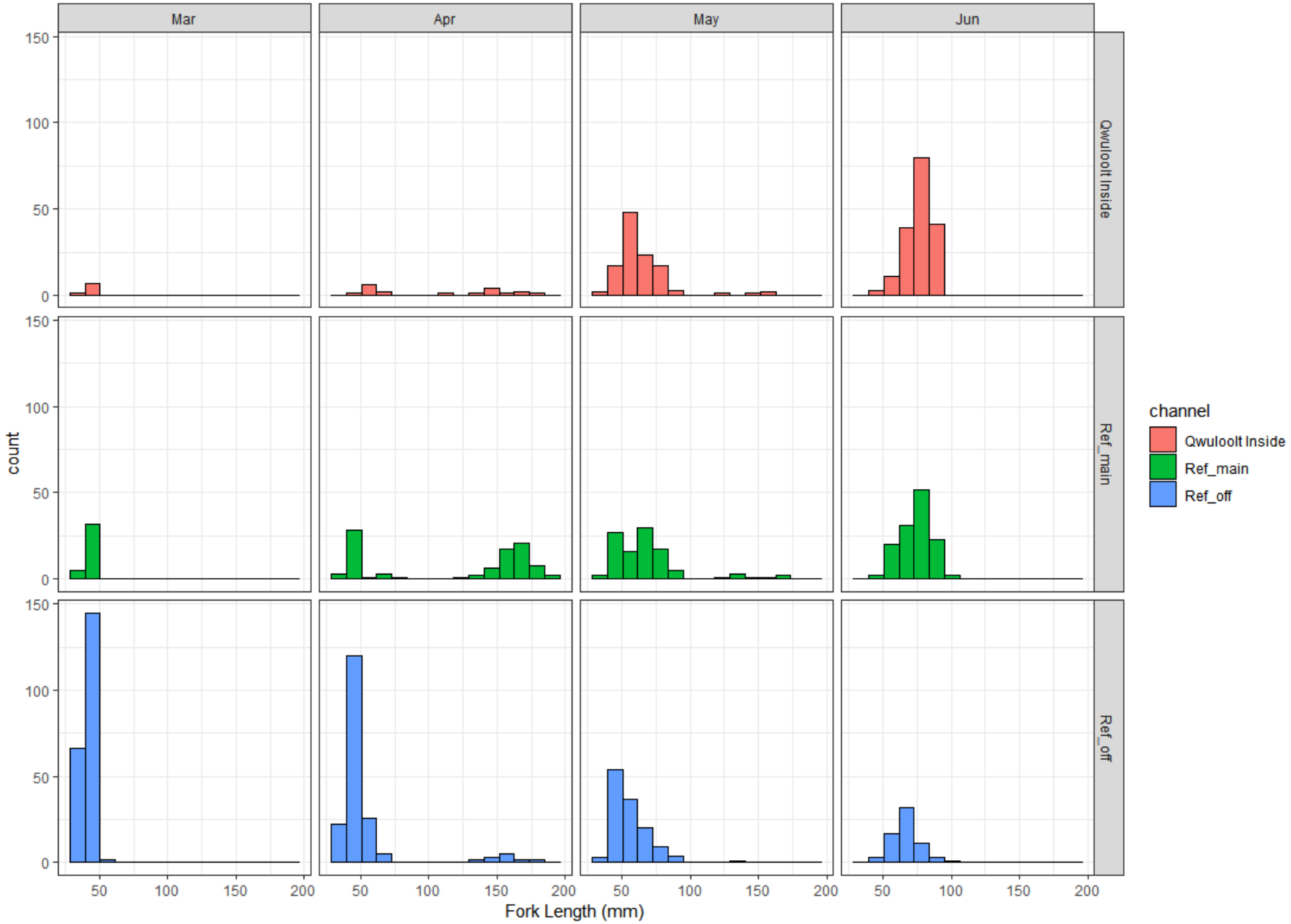
Before/After Restoration fish assemblage comparisons



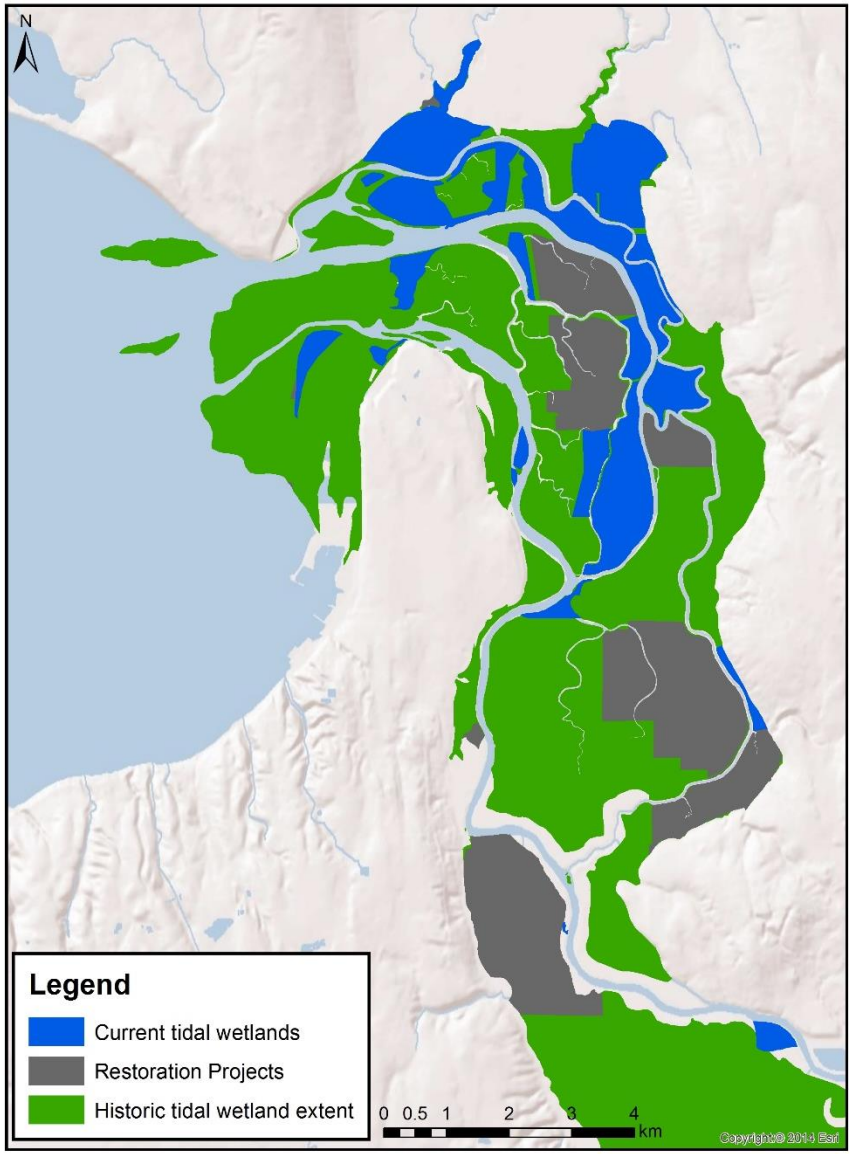
Qwuloolt trending toward reference/estuarine assemblage conditions


BREACH
2012
2013
2014
2015
2016
2017
Chinook Density (# fish/ hectare)
7000
6000
5000
4000
3000
2000
1000
0
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Qwuloolt Inside
Ref Blind
Ref Dist

Fork length distributions resemble adjacent slough sites more than reference off channel sites



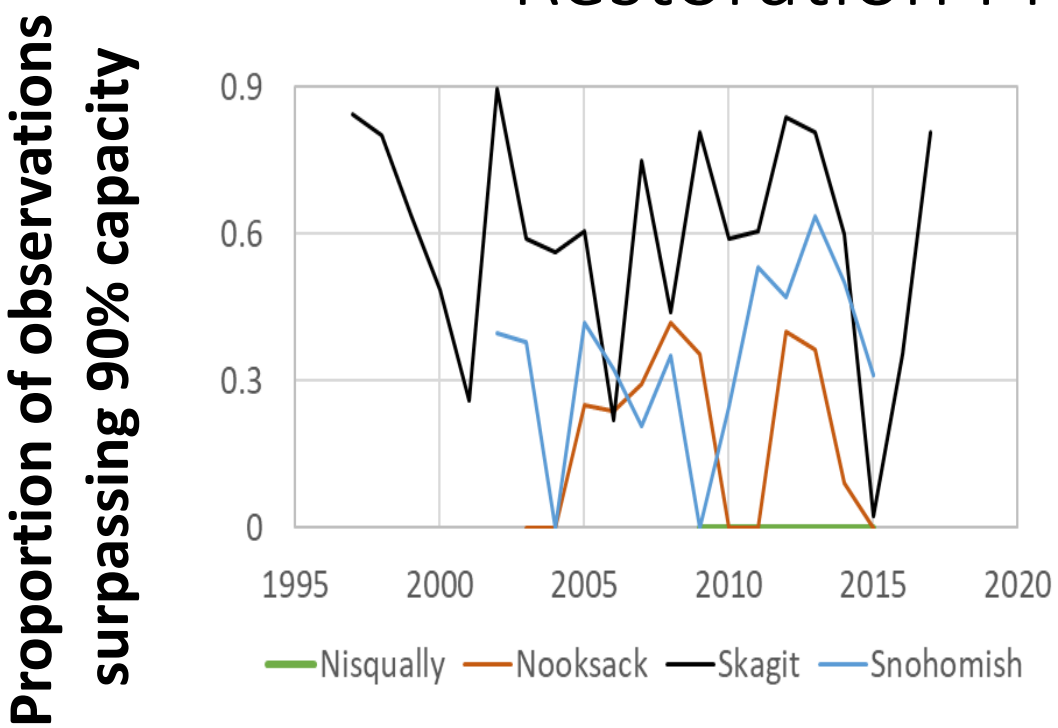
Restoration Prioritization



- Restoration has added estuary habitat area
- Habitat area not well distributed

- Additional restoration potential exists
- Restoration is costly and time consuming
- Need for prioritization

Restoration Prioritization



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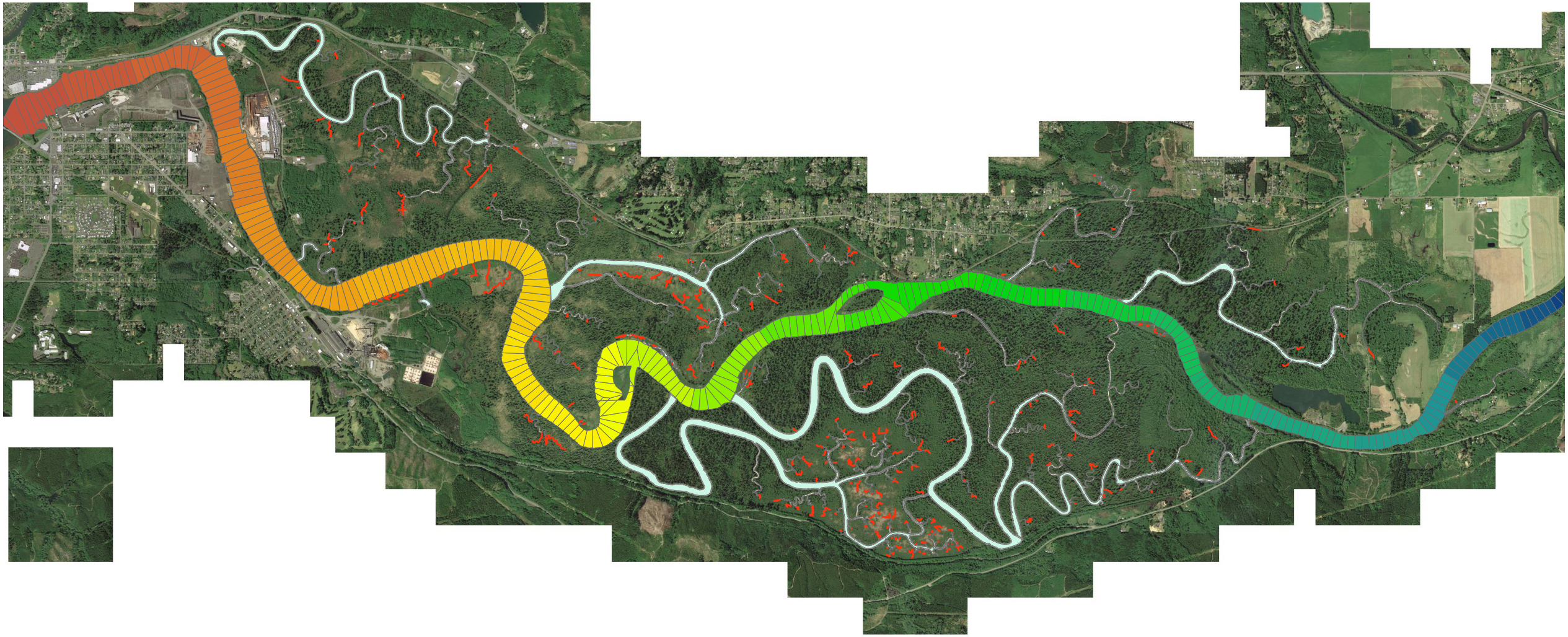
- Additional restoration potential exists
- Restoration is costly and time consuming
- Need for prioritization

Skagit:	60%
Snohomish:	34%
Nooksack:	18%
Nisqually:	0%

Greene et al. in prep

- Update/revise capacity estimates in the system
- Scaled estimates based on attributes known to influence fish use/density
- Establish/run scenarios
- Which sites offer biggest potential return?

Delta capacity estimates



Skagit tidal delta sub-yearling Chinook density

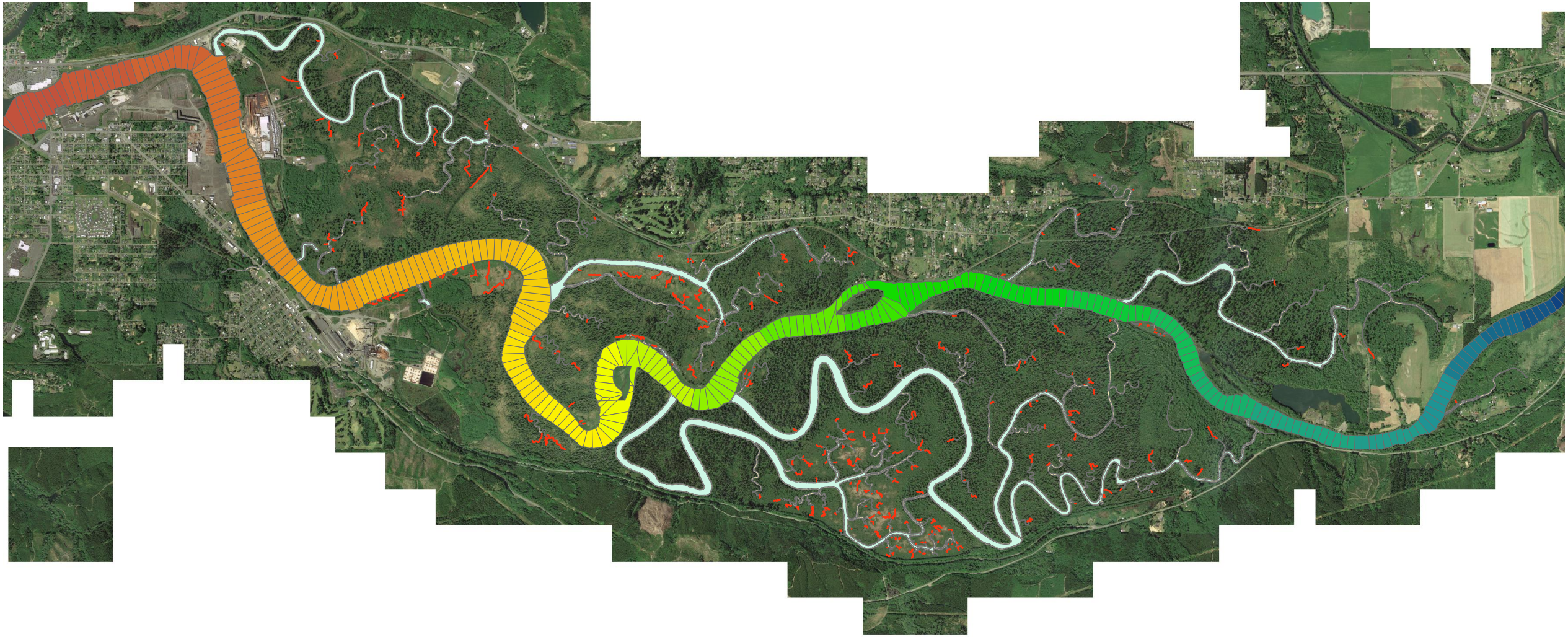
daily juv CK density at carrying capacity (fish/m^3)	1.314
ave. blind channel depth (m)	0.64
daily juv CK density at carrying capacity (fish/m^2)	0.841
estuarine rearing period (days)	196
ave. residence time of individual fish (days)	35
juv CK carry capacity (fish/yr/m^2)	4.709
juv CK carry capacity (fish/yr/ha)	47,094

Delta habitat categories and values

- 10m edge buffer; incorporates benefits of depth, velocity, and vegetation.
- Main Channel
  - Edge
    - Vegetation using a 60m buffer
      - Veg = 0.25 * max
      - Unveg = 0.125 * max
  - Non-edge
    - No value

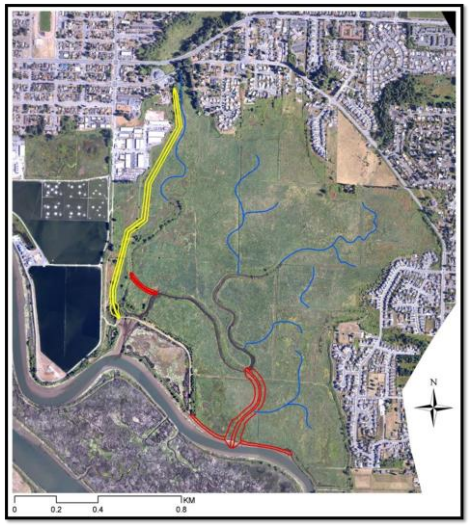
- Tidal Channel (all considered vegetated)
  - Edge = max capacity
  - Non-edge = 0.5 * max

Delta capacity estimates



Work to begin for Snohomish estuary in July 2019

Restoration Design and Effectiveness



What we have:

- Comprehensive fish data
  - Assemblage and species specific
- RTK elevation transects
- Sediment Elevation Tables
- Intensive and Extensive Vegetation

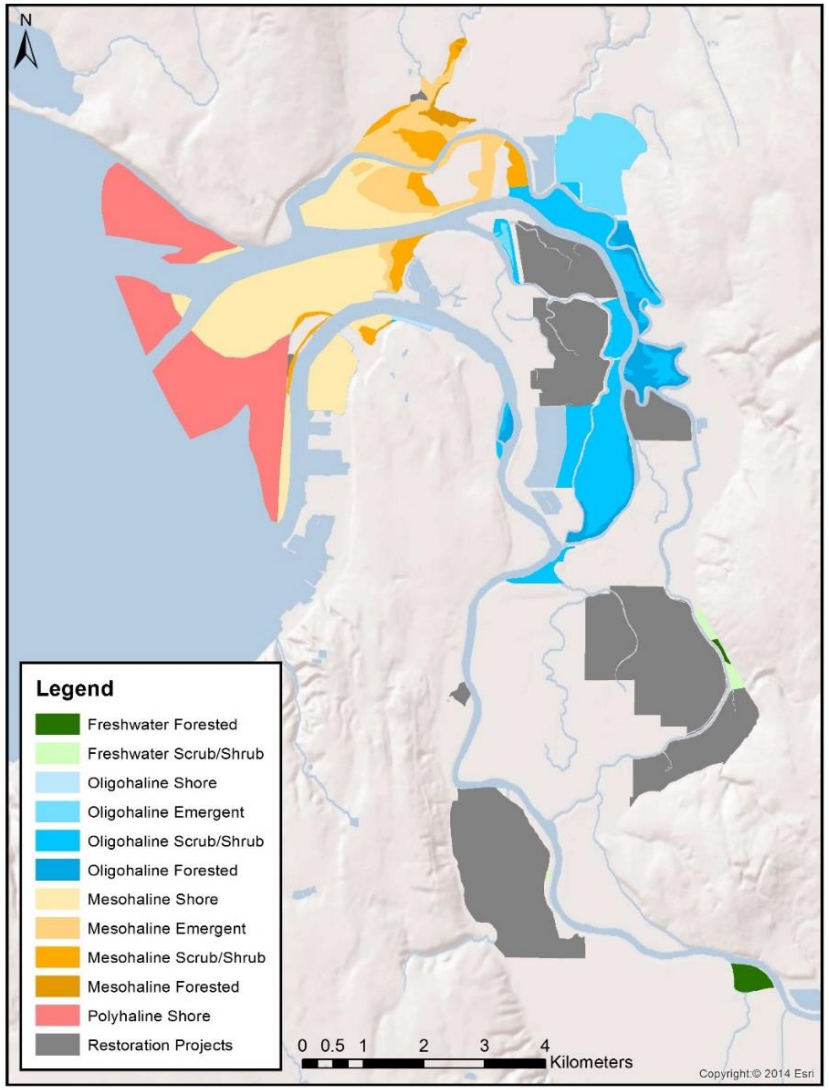
What we don't have:

- Sediment budget
  - Sediment dynamics
- Flow data in/out of project sites

Questions:

- Does design influence fish use?
- Does design influence potential site trajectory?
- How cold changes in trajectory impact functional performance?

Cumulative effects of restoration



- Population effects
  - Snohomish—too early?
  - ESRP funding to be awarded
- Habitat and Hydrological effects
  - Multiple large projects in same area
  - Different designs/features
- How does restoration of tidal processes impact local/system hydrology?
- How do potential changes to hydrology affect local environment?
  - Temperature/salinity
- Update/revise recovery plans and targets

Thank You!